

Claims

- [c1] 1. A liquid crystal display (LCD) structure, comprising a first substrate panel, a second substrate panel, and a liquid crystal layer disposed between the first substrate panel and the second substrate panel, a plurality of pixel portions being formed by respective electrodes for applying a voltage to the liquid crystal layer, each of the pixel portions comprising
an organic insulating layer over the first substrate panel, wherein the surface of the organic insulating layer has a plurality of protrude/recess structures thereon;
a conformal reflective layer over the organic insulating layer, wherein the conformal reflective layer serves as a reflector of light;
a dielectric layer over the conformal reflective layer, wherein the dielectric layer has a smoother upper surface than the bumpy organic insulating layer; and
a first transparent conductive layer over the dielectric layer.
- [c2] 2. The LCD structure of claim 1, wherein the first substrate panel includes a glass panel.
- [c3] 3. The LCD structure of claim 1, wherein the material forming the organic insulating layer includes an acrylic resin.
- [c4] 4. The LCD structure of claim 1, wherein the material forming the organic insulating layer includes a photosensitive resin.
- [c5] 5. The LCD structure of claim 1, wherein the first substrate panel further includes a thin film transistor having a gate electrode, a source terminal and a drain terminal over the first substrate panel.
- [c6] 6. The LCD structure of claim 5, wherein the first transparent conductive layer is connected to the thin film transistor for controlling the liquid crystal layer.
- [c7] 7. The LCD structure of claim 1, wherein the material forming the conformal reflective layer includes aluminum or silver or a reflective non-conducting material.
- [c8] 8. The LCD structure of claim 1, wherein the dielectric layer includes a color

filter layer.

- [c9] 9. The LCD structure of claim 1, wherein the dielectric layer includes a transparent insulating material layer.
- [c10] 10. The LCD structure of claim 1, wherein the LCD further includes:
 - a second substrate that is aligned to the first substrate panel;
 - a second transparent conductive layer over the second substrate panel; and
 - a liquid crystal layer between the second transparent conductive layer and the first transparent conductive layer.
- [c11] 11. The LCD structure of claim 10, wherein the surface of the second substrate panel on the opposite side of the liquid crystal layer further includes a phase compensation plate and a polarizer.
- [c12] 12. The LCD structure of claim 10, wherein the dielectric layer includes a transparent insulating material layer.
- [c13] 13. The LCD structure of claim 12, wherein the LCD further includes a color filter layer between the second substrate panel and the second transparent conductive layer.
- [c14] 14. A liquid crystal display (LCD) structure, comprising a first substrate panel, a second substrate panel, and a liquid crystal layer disposed between the first substrate panel and the second substrate panel, a plurality of pixel portions being formed by respective electrodes for applying a voltage to the liquid crystal layer, each of the pixel portions comprising
 - an organic insulating layer over the first substrate panel, wherein the surface of the organic insulating panel includes a plurality of protrude/recess structures;
 - a conformal transparent conductive layer over a portion of the organic insulating layer; and
 - a plurality of reflectors over the organic insulating layer and/or the conformal transparent conductive layer so that a portion of the conformal transparent conductive layer is exposed, wherein the transparent conductive layer and the reflectors are alternately laid with some regions overlapped and are connected electrically, wherein the exposed conformal transparent conductive layer

occupies roughly 1% to 60% of the total area of the organic insulating layer, the region having the reflectors is reflective region, and the region having the exposed transparent conductive layer is a transmission I region.

- [c15] 15. The LCD structure of claim 14, wherein the first substrate panel includes a glass panel.
- [c16] 16. The LCD structure of claim 14, wherein material forming the organic insulating layer includes an acrylic resin.
- [c17] 17. The LCD structure of claim 14, wherein material forming the organic insulating layer includes a photosensitive resin.
- [c18] 18. The LCD structure of claim 14, wherein each protrude/recess structure is divided into a first region and a second region depending on the reflecting angle according to the following relationship: assuming a beam of incoming light strikes a surface having protrude/recess structures covering a reflective layer entirely and producing reflected light, if the reflected lights distribute within a preferable observation range, the region in the protrude/recess structure that corresponds to such a range is defined to be the first region, the reflectors cover the first region for normal operation, and if the reflected lights would spread outside the preferable observation range, the regions in the protrude/recess structure that correspond to such difficult-to-see range are defined to be the second region, and the exposed transparent conductive layers are in the second region.
- [c19] 19. The LCD structure of claim 14, wherein the LCD further includes a thin film transistor having a gate electrode, a source terminal and a drain terminal over the first substrate panel.
- [c20] 20. The LCD structure of claim 19, wherein the reflectors or the transparent conductive layer or both and the thin film transistor are electrically connected.
- [c21] 21. The LCD structure of claim 14, wherein the LCD further includes:
a second substrate panel corresponding to the first substrate panel;
a color filter layer over the second substrate panel;

a second transparent conductive layer over the color filter layer; and
a liquid crystal layer between the second transparent conductive layer and the
first substrate panel.

[c22] 22. The LCD structure of claim 21, wherein the LCD further includes a back lighting system attached to the side of the first substrate panel on the other side of the second substrate panel such that a portion of the emitted light from the back lighting system passes through the transmission electrode, and the remaining portion of the emitted light reflects back from the reflective electrode and reused.

[c23] 23. The LCD structure of claim 21, wherein each side of the first substrate panel and the second substrate panel away from the liquid crystal layer further includes a phase compensation plate and a polarizer.

[c24] 24. A liquid crystal display (LCD) structure, comprising:
a first substrate panel with a plurality of pixel portions being formed by respective electrodes for applying a voltage to the liquid crystal layer, each of the pixel portions comprising:
an organic insulating layer over the first substrate panel, wherein the surface of the organic insulating layer has a plurality of protrude/recess structures or bumps;
a plurality of reflectors over the organic insulating layer such that portions of the organic insulating layer are exposed, wherein the reflectors expose about 1 to 60% of the overall organic insulating layer area, the reflectors form a reflector of light and the exposed organic insulating areas form the transmission areas, and the reflectors and the exposed organic insulating areas are alternately laid with respect to each other;
a dielectric layer over the reflectors and the exposed organic insulating areas, wherein the upper surface of the dielectric layer is smoother than the protrude/recess structure of the organic insulating layer; and a first transparent conductive layer over the dielectric layer.

[c25] 25. The LCD structure of claim 24, wherein each protrude/recess structure may be divided into a first region and a second region depending on the viewing

angle according to the following relationship:

assuming a beam of incoming light strikes a surface having protrude/recess structures covered by a reflective layer entirely and produces reflected lights, if the reflected lights distribute within a preferable observation range, the region in the protrude/recess structure that corresponds to such a range is defined to be the first region serving as the reflectors region, and if the reflected light spreads outside the preferable observation range, the region in the protrude/recess structure that correspond to such difficult-to-see range is defined to be the second region where the reflectors are removed, and the exposed transmission areas are in the second region.

- [c26] 26. The LCD structure of claim 24, wherein the LCD further includes a thin film transistor having a gate electrode, a source terminal and a drain terminal over the first substrate panel.
- [c27] 27. The LCD structure of claim 24, wherein the dielectric layer includes a color filter layer.
- [c28] 28. The LCD structure of claim 24, wherein the dielectric layer includes a transparent insulating material layer.
- [c29] 29. The LCD structure of claim 24, wherein the LCD further includes:
 - a second substrate panel corresponding to the first substrate panel;
 - a second transparent conductive layer over the second substrate panel; and
 - a liquid crystal layer between the second transparent conductive layer and the first transparent conductive layer.
- [c30] 30. The LCD structure of claim 29, wherein the LCD further includes a phase compensation plate and a polarizer on each exterior-facing side of the first substrate panel and the second substrate panel away from the liquid crystal layer.
- [c31] 31. The LCD structure of claim 29, wherein the dielectric layer includes a transparent insulating material layer.
- [c32] 32. The LCD structure of claim 31, wherein the LCD further includes a color

filter layer between the second substrate panel and the second transparent conductive layer.

[c33] 33. The LCD structure of claim 29, wherein the LCD further includes a back lighting system attached to the side of the first substrate panel on the other side of the second substrate panel such that a portion of the emitted light from the back lighting system passes through the transmission electrode, and the remaining portion of the emitted light reflects back from the reflective electrode and reused.

[c34] 34. A liquid crystal display transflective layer structure in a pixel portion of a liquid crystal display structure, comprising:
an organic insulating layer having a plurality of protrude/recess structures thereon; and
a reflective layer over the organic insulating layer, wherein the reflective layer has a plurality of openings such that the openings form a plurality of transmission regions and the reflective layer form a plurality of reflective regions.

[c35] 35. The transflective layer structure of claim 34, wherein the transmission regions occupy about 1 to 60% of the overall area of the organic insulating layer.

[c36] 36. A liquid crystal display reflective layer structure in a pixel portion of a liquid crystal display structure, comprising:
an organic insulation layer having a plurality of protrude/recess structures thereon; a reflective layer over the organic insulating layer;
a dielectric layer over the reflective layer, wherein the upper surface of the dielectric layer is smoother than the protrude/recess structure covered organic insulating layer; and
a transparent conductive layer over the dielectric layer.

[c37] 37. The reflective layer structure of claim 36, wherein the dielectric layer includes a color filter layer.

[c38] 38. The reflective layer structure of claim 36, wherein the dielectric layer

includes a transparent insulating material layer.

[c39] 39. A liquid crystal display transreflective layer structure in a pixel portion of a liquid crystal display structure, comprising:
an organic insulation layer having a plurality of protrude/recess structures thereon;
a patterned reflective layer over the organic insulating layer;
a dielectric layer over the patterned reflective layer, wherein the upper surface of the dielectric layer is smoother than the protrude/recess structure covered organic insulating layer; and a transparent conductive layer over the dielectric layer.

[c40] 40. The transreflective layer structure of claim 39, wherein the dielectric layer includes a color filter layer.

[c41] 41. The transreflective layer structure of claim 39, wherein the dielectric layer includes a transparent insulating material layer.

[c42] 42. A liquid crystal display transreflective layer structure in a pixel portion of a liquid crystal display structure, comprising:
an organic insulating layer having a plurality of protrude/recess structures thereon;
a conformal transparent conductive layer over a portion of the organic insulating layer;
a patterned reflective layer over the organic insulating layer and/or the conformal transparent conductive layer; wherein the transparent conductive layer and the patterned reflective layer are formed in alternate locations with some regions overlapped, and the two layers together form a continuous electrical connection.

[c43] 43. The transreflective layer structure of claim 42, wherein the transparent conductive layer and the patterned reflective layer have some overlapping regions and form a continuous electrical connection.